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Application of sea surface temperature remote sensing data in environmental assessment of fishing grounds

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Abstract. This article provides a comprehensive discussion of the application and importance of sea surface temperature (SST) remote sensing data in environmental assessment of fisheries. By analysing the collection, processing and practical application of SST data, the article demonstrates how this technology can help scientists and fisheries managers to better understand the impacts of ocean temperature changes on fisheries resources and its role in ensuring the sustainability of global fisheries. The article begins by describing the importance of the marine environment to fishery resources and explains the development of SST remote sensing technology and its application to fishery location and environmental monitoring. The article then discusses in detail the application of SST data in practical fisheries management, in particular how it can help predict fish migration, optimise fishing activities, and assess the impacts of climate change on marine ecosystems. In addition, the article explores the main challenges faced when applying SST data, such as technical limitations, complexity of data interpretation, and unequal access on a global scale. Overall, this article highlights the indispensable role of SST remote sensing data in modern fisheries management, while also pointing out the limitations of its application and future directions. With the continuous advancement of remote sensing technology and the ongoing impact of global climate change, SST data are expected to play an increasingly important role in future fisheries environmental assessment and resource management.

Keywords: sea surface temperature remote sensing; fishery environment assessment; climate change; fishery resource management; satellite data application.

1. Introduction

In the context of global fisheries resource management, accurate assessment of the marine environment has become an urgent need. This paper explores the critical role of sea surface temperature (SST) remote sensing data in environmental assessment of fishing grounds and how this technology can help us better understand and utilise marine resources. As global climate change increasingly impacts marine ecosystems, accurate fishery assessments become particularly important to ensure the sustainability of fisheries.

Firstly, we must recognise the importance of the marine environment to fisheries resources. The oceans are not only the world's largest ecosystem, but also an important source of food, livelihoods and economic activity for human beings. The survival and reproduction of fish and other marine organisms are directly affected by changes in the marine environment, with temperature being one of the most influential environmental factors [1]. Due to the sensitivity of some fish species to water temperature, changes in ocean temperature can lead to changes in the distribution of fish populations, which can have a significant impact on fishing activities.

In this context, SST remote sensing data becomes an invaluable tool. Through satellites and other high-tech equipment, scientists can collect precise data on ocean surface temperatures, which are essential for understanding fish behaviour, predicting the location of fishing grounds and assessing the fishing environment. Remote sensing provides a broader and more continuous range of data than traditional ship-based observations, allowing for more efficient and accurate management of fisheries resources.

However, although SST data provide detailed information on sea surface temperature, they still face challenges in practical applications. For example, cloud cover and atmospheric disturbances may affect the accuracy of the data [2]. In addition, SST data can only provide surface temperature information and do not reflect the deeper layers of the ocean. Therefore, the application of these data to environmental assessment of fisheries requires the integration of other ocean data and fisheries knowledge.

The aim of this paper is to explore the application of SST remote sensing data in fisheries environmental assessment and to analyse the strengths and limitations of this technique. By looking at how SST data can help us to better understand the fishery environment and its application to practical fisheries resource management, we can assess the potential contribution of this technology to the sustainability of future fisheries. Considering the pressures and challenges facing global fisheries, such an assessment is important for the development of effective fisheries management policies and practices.

2. Related Work

In exploring the application of sea surface temperature (SST) remote sensing data in environmental assessment of fisheries, it is critical to review related work. These works not only demonstrate the historical development and technological advances in SST data, but also provide insight into current research and applications.

Initially, studies of ocean temperature relied heavily on direct measurements from ships and buoys, and while these methods provided accurate localised data, they had very limited coverage in time and space [3]. With the development of satellite technology, remote sensing became the primary means of monitoring sea surface temperature. Early SST satellite programmes, such as NOAA's Advanced Very High Resolution Radiometer (AVHRR), offered the possibility of continuous observations of global sea surface temperature. These data have contributed significantly to our understanding of the ocean temperature distribution and its seasonal and long-term variability.

In recent years, the application of SST data has expanded from basic oceanographic studies to a wider range of fields, with increasing use in environmental assessment of fisheries in particular. Scientists have used SST data to analyse environmental conditions in specific fisheries, such as temperature anomalies and changes in ocean currents, which are key factors affecting fish distribution and behaviour [4]. For example, a number of studies have used SST data to track the impacts of El Niño and La Niña events on marine ecosystems, climatic phenomena that have been shown to lead to significant ocean temperature changes that affect the abundance and distribution of fish stocks.

In addition, important advances have been made in the application of SST data to predict fish migration and optimise fishing activities. By analysing sea surface temperature (SST) patterns, researchers are able to predict potential aggregation areas for certain fish species, thereby guiding fisheries practices to improve fishing efficiency and reduce fishing for non-target species. This not only promotes the sustainable use of fishery resources, but also helps reduce the overall impact on the marine ecosystem.

Recently, SST data analysis methods have advanced with the development of big data and machine learning techniques. Modern data processing techniques are able to process and analyse large amounts of remotely sensed data more efficiently, providing more accurate and nuanced information on ocean temperatures [5]. This allows scientists to gain a deeper understanding of the complex relationships between ocean temperature changes and global climate change, marine ecosystem health, and fishery resources.

Overall, the application of SST remote sensing data in the field of environmental assessment of fisheries has a long and varied history. From the first direct measurements to modern satellite remote sensing to the latest data processing techniques, each step of progress has provided deeper insights. These related works not only confirm the importance of SST data in marine science and fisheries

management, but also provide a solid foundation for future research directions and applications. With the continuous development of technology and the ongoing impacts of global climate change, it is expected that SST data will continue to play an important role in environmental assessment and management of fisheries in the future.

3. Remote sensing techniques and sea surface temperature data

In modern marine scientific research, remote sensing has become a key tool for detecting and analysing Sea Surface Temperature (SST).SST data have important applications for understanding marine ecosystems, especially in environmental assessment of fishing grounds. Remote sensing technology obtains information about the surface and atmosphere through long-range sensing equipment such as satellites or aircraft, with infrared and microwave remote sensing being the main modalities for monitoring SST [6].

Infrared remote sensing is capable of detecting infrared radiation emitted from the ocean surface and thus deriving temperatures. This method has the advantage of providing high-resolution temperature data, but its limitation is that it cannot penetrate cloud cover, so the data obtained may be inaccurate in cloudy or foggy weather. On the other hand, microwave remote sensing is not affected by cloud cover and can work in any weather conditions, but it provides data with relatively low resolution. To overcome these limitations, scientists usually use a combination of data acquired by multiple sensors to improve coverage and data accuracy [7].

Data collection of sea surface temperature is only the first step in the application of remote sensing. Next, these data need to be finely processed and analysed for more accurate understanding and use. First, the raw data need to be corrected to remove interference from the atmosphere and other environmental factors. Then, through algorithms and models, the observed radiation values are converted into temperature values. In addition, in order to provide a more accurate global SST map, scientists need to fuse and match data acquired by different sensors.

The reliability and accuracy of sea surface temperature (SST) data is critical for environmental assessment of fishing grounds. Fisheries scientists and managers rely on these data to identify fishing grounds, predict fish migration paths, and monitor the effects of environmental changes on marine life [8]. For example, certain fish species prefer waters in specific temperature ranges, and SST data allow the specific location of these temperature zones to be determined. In addition, changes in sea surface temperature can be used as an indicator of changes in the marine environment, such as increased temperatures due to global warming that may affect the growth and migration patterns of fish.

However, although remote sensing technology provides an effective means of observing sea temperatures, there are still challenges in its application. First, data interpretation requires a high degree of precision and expertise, and incorrect interpretations may lead to wrong decisions. Secondly, although developments in remote sensing technology have greatly improved data acquisition, high-quality data processing and analysis still require expensive technology and expertise [9]. Finally, the degree of access and utilisation of this technology varies in different parts of the globe, which may affect the effectiveness and equity of fisheries resource management on a global scale.

Overall, remote sensing technology and the sea surface temperature (SST) data it provides play a crucial role in the environmental assessment of fisheries. By accurately monitoring and analysing SST, scientists and resource managers are able to better understand and manage marine resources. Despite some challenges, remote sensing data will play an increasingly important role in the future of marine science and resource management as technology continues to advance and data processing capabilities increase.

4. Application of environmental assessment to fisheries

Environmental assessment of fishing grounds plays a crucial role in global fisheries resource management. This process involves not only the location and monitoring of fishing grounds, but also a comprehensive assessment of the environmental health and sustainability of fishing grounds. In this regard, the application of sea surface temperature (SST) data, which are often obtained through advanced remote sensing techniques, has become a key factor.

Firstly, SST data play an important role in determining the location of fishing grounds. Many fish stocks tend to operate within specific temperature ranges, and these temperature zones can be identified by analysing SST data. For example, warmer waters may be more suitable for certain species of fish, while colder waters may attract another type of fish. By monitoring SST over time, scientists can identify areas where fish are likely to congregate, which can help fishermen locate fishing grounds more effectively, reduce fishing effort and increase fishing efficiency [10].

In addition to locating fishing grounds, SST data are critical for monitoring environmental changes and their impacts on fishing grounds. Changes in ocean temperatures due to climate change and global warming may have far-reaching impacts on fish migration patterns, breeding habits and food chains. By continuously monitoring SST, scientists are able to track these changes and assess their potential impacts on fishing ecosystems. For example, unusually high ocean temperatures may cause certain species to migrate to new habitats or affect their reproductive cycles. This kind of information is crucial for developing adaptive management strategies to ensure the sustainability of fisheries.

Practical examples demonstrate the use of SST data in environmental assessment of fisheries. For example, in a study of the North Atlantic, scientists found that changes in ocean temperatures were closely linked to shifts in the distribution of commercially important fish species such as cod and Arctic pollock. Such analyses have helped to understand the dynamics of fishery resources and have guided the adjustment of fishing seasons and the setting of fishing quotas.

However, there are challenges in applying SST data to fishery assessments. The marine environment is extremely complex, with much more than temperature influencing the distribution of fish stocks. Other factors, such as salinity, currents, nutrient availability, and human activities (e.g., overfishing and pollution) also have a significant impact on stock distribution. Therefore, relying solely on SST data for fishery assessment may lead to one-sided conclusions[11]. Effective fisheries management requires the integration of multiple data and information, including biological, ecological, and socio-economic considerations.

Looking ahead, the accuracy and availability of SST data will continue to increase as remote sensing technology continues to advance and data processing algorithms improve. This will enable more accurate and efficient environmental assessment of fisheries and help achieve sustainable use of fishery resources. At the same time, it provides scientists and resource managers with more powerful tools to address the impacts of climate change on marine ecosystems.

Overall, the application of SST data in fishery environmental assessment has great potential. It not only helps to improve fishing efficiency, but more importantly, it plays a key role in protecting marine ecosystems and promoting sustainable management of fishery resources. Future research and applications need to pay more attention to data integration and interdisciplinary co-operation in order to comprehensively understand and respond to the impacts of changes in the marine environment on fisheries.

5. Conclusion

This paper reveals the importance of sea surface temperature (SST) remote sensing data for modern fisheries management by providing an in-depth analysis of the use of this technology in environmental assessment of fishing grounds. The use of remote sensing technology, especially SST data, has proven to be a key tool in understanding and managing marine resources. The application

of this technology not only improves fishing efficiency, but also has far-reaching implications for the protection of marine ecosystems and the promotion of sustainable management of fishery resources.

The importance of SST data is first and foremost in its ability to help pinpoint fishing grounds. By analysing the temperature distribution of the ocean surface, scientists and fisheries managers are able to identify areas where fish congregate, thereby guiding fishermen to more efficient fishing. This not only reduces unnecessary fishing effort, but also reduces pressure on marine ecosystems. In addition, SST data play an important role in monitoring the impacts of climate change and environmental factors on marine ecosystems. As the global climate warms, marine ecosystems are changing, which directly affects fish habitat and migration patterns. By monitoring SST over time, we are able to better understand these changes and develop appropriate adaptation measures.

However, the application of SST data also faces challenges. The complexity and variability of data interpretation require a high degree of expertise and technical competence from scientists. In addition, limitations of remote sensing technology and incomplete data can lead to misinterpretation. Therefore, while SST data provide valuable information for fisheries resource management, it is only one part of the decision-making process. Effective fisheries management also requires consideration of other biological, ecological and socio-economic factors.

In the future, with the continuous development of remote sensing technology and the improvement of data processing capabilities, we expect that the application of SST data in environmental assessment of fisheries will become more extensive and precise. In addition, interdisciplinary research methods, including integrated analyses of biology, ecology, meteorology and socioeconomics, will be essential for a comprehensive understanding and management of fishery resources. In order to achieve sustainable use of fishery resources, scientists, policy makers, and fishing communities must work together to focus not only on the economic benefits of fisheries, but also on their impacts on the marine environment.

In conclusion, the application of SST remote sensing data in environmental assessment of fisheries demonstrates how modern technology can help us better understand and manage natural resources. With the advancement of technology and deeper understanding of marine ecosystems, we have reason to believe that fisheries management in the future will be more scientific, efficient and sustainable. The application of SST data provides an effective solution to the marine resource management challenges facing the world. Despite the challenges, through interdisciplinary cooperation and continued technological innovation, we are expected to achieve a more rational and sustainable use of marine resources.

6. Discussion

In exploring the use of sea surface temperature (SST) remote sensing data in environmental assessment of fisheries, it is important to acknowledge the multiple benefits and challenges of this technology. The use of this technology has become an integral part of modern marine science and fisheries management, but its complexities and limitations have generated extensive discussion.

Firstly, one of the greatest strengths of SST remotely sensed data is the continuous and extensive monitoring of sea surface temperature dynamics that it provides. This is critical for understanding patterns of fish behaviour. Many fish species are very sensitive to ambient temperature, and small changes in temperature can affect their migration routes, reproductive behaviour, and food sources. As a result, SST data have become a critical tool for predicting the distribution and abundance of fish populations. For example, fisheries managers rely on these data to determine where and when fishermen should fish in order to maximise fishing efficiency and minimise impacts on the ecosystem.

However, SST data have some limitations in their application. Most notably, these data are affected by cloud cover and other atmospheric conditions and may not provide accurate temperature readings in some cases. In addition, SSTs only provide temperature information at the sea surface and do not directly reflect conditions in the deep-sea layer, which poses a limitation for the management of deep-

sea fisheries resources. A further important consideration is that marine ecosystems are extremely complex and a single temperature data does not provide a comprehensive picture of all the factors affecting the fishing environment. For example, factors such as salinity, currents and ocean acidification also have a significant impact on fish habits.

Another aspect worth discussing for the application of SST data in fisheries environmental assessment is its significance for long-term fisheries resource management. As climate change intensifies, ocean temperature patterns are changing, which may lead to long-term changes in the migration routes and distribution of fish populations. In this context, SST data will not only help to monitor environmental changes in the short term, but will also help scientists and policy makers to understand and predict long-term trends, leading to more effective fisheries management policies. However, it also requires scientists to collect and analyse ocean temperature data on a long-term and continuous basis, which is not only technically demanding but also requires stable financial support.

In addition, the application of SST data is uneven across regions and countries. Developed countries usually have better technology and resources to collect and analyse these data, while developing countries may have significant deficiencies in this regard. Such imbalances may lead to inconsistencies in fisheries management on a global scale, affecting the sustainability of global fisheries resources. Therefore, international co-operation and knowledge sharing are particularly important in this regard.

Finally, the discussion of the application of SST data in environmental assessment of fisheries should not neglect its interaction with fisher communities. As direct participants in fisheries management, fishermen's observations and experiences of the marine environment are equally important.Effective use of SST data requires not only the involvement of scientists and policy makers, but also the participation and support of fishermen. By working with fisher communities, these data can be used more effectively while ensuring the sustainability of fishing practices.

In summary, the application of SST remote sensing data in environmental assessment of fisheries undoubtedly has great potential, but its effective implementation needs to take into account a combination of technological, ecological, socio-economic, and policy factors. A more comprehensive and coordinated approach in future research and practice will be the key to improving the efficiency and effectiveness of these data applications.

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